



# Desiccant and ERV “Systems” and Technology Applications Overview



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**Oak Ridge National Laboratory**

**Integrated Energy Systems (IES)**

**Peer Review Meeting**

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**OAK RIDGE NATIONAL LABORATORY**  
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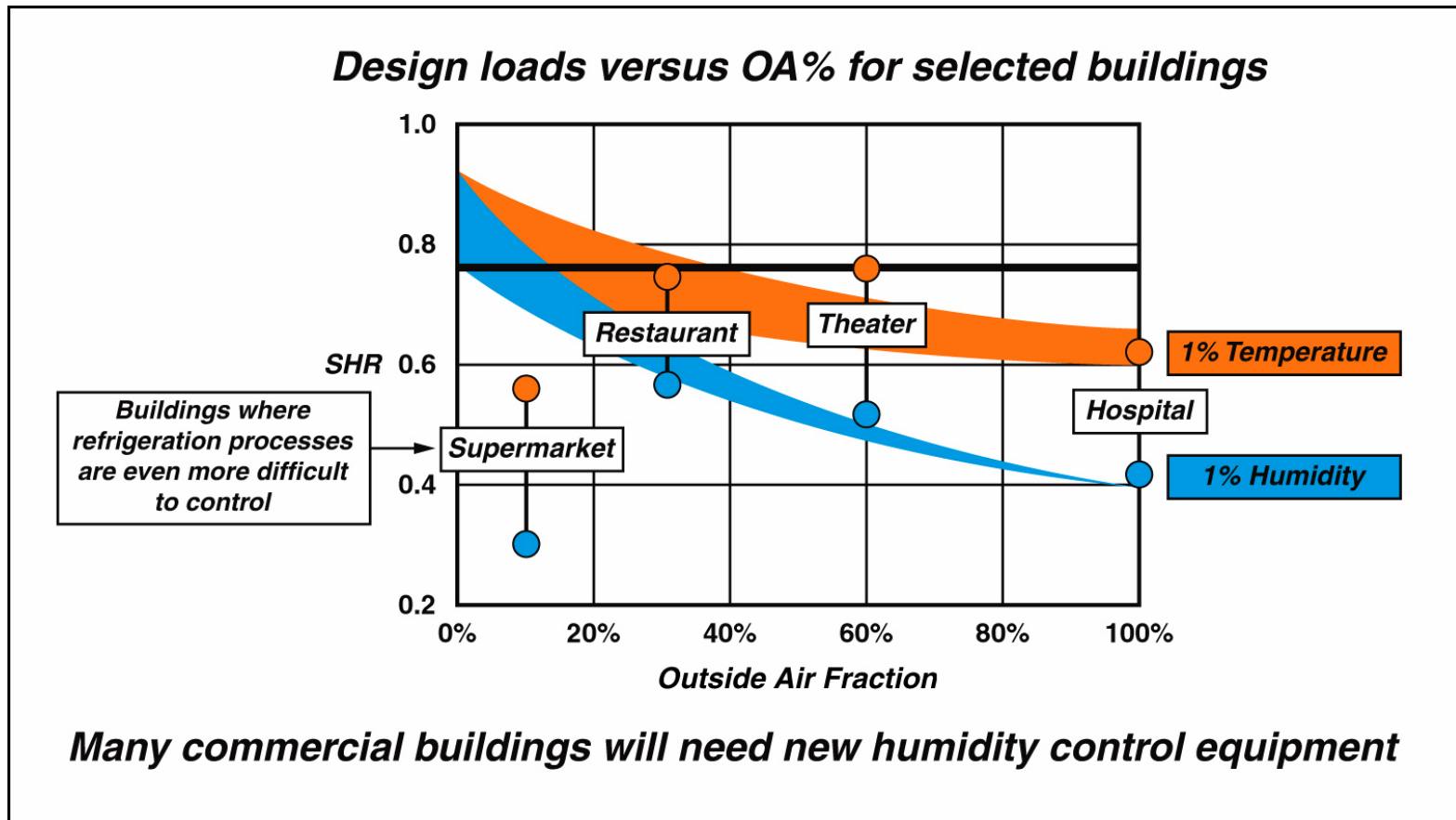


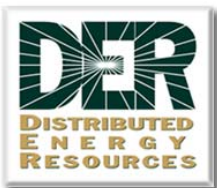


# Indoor Air Quality, Design Loads, Equipment SHR Drivers

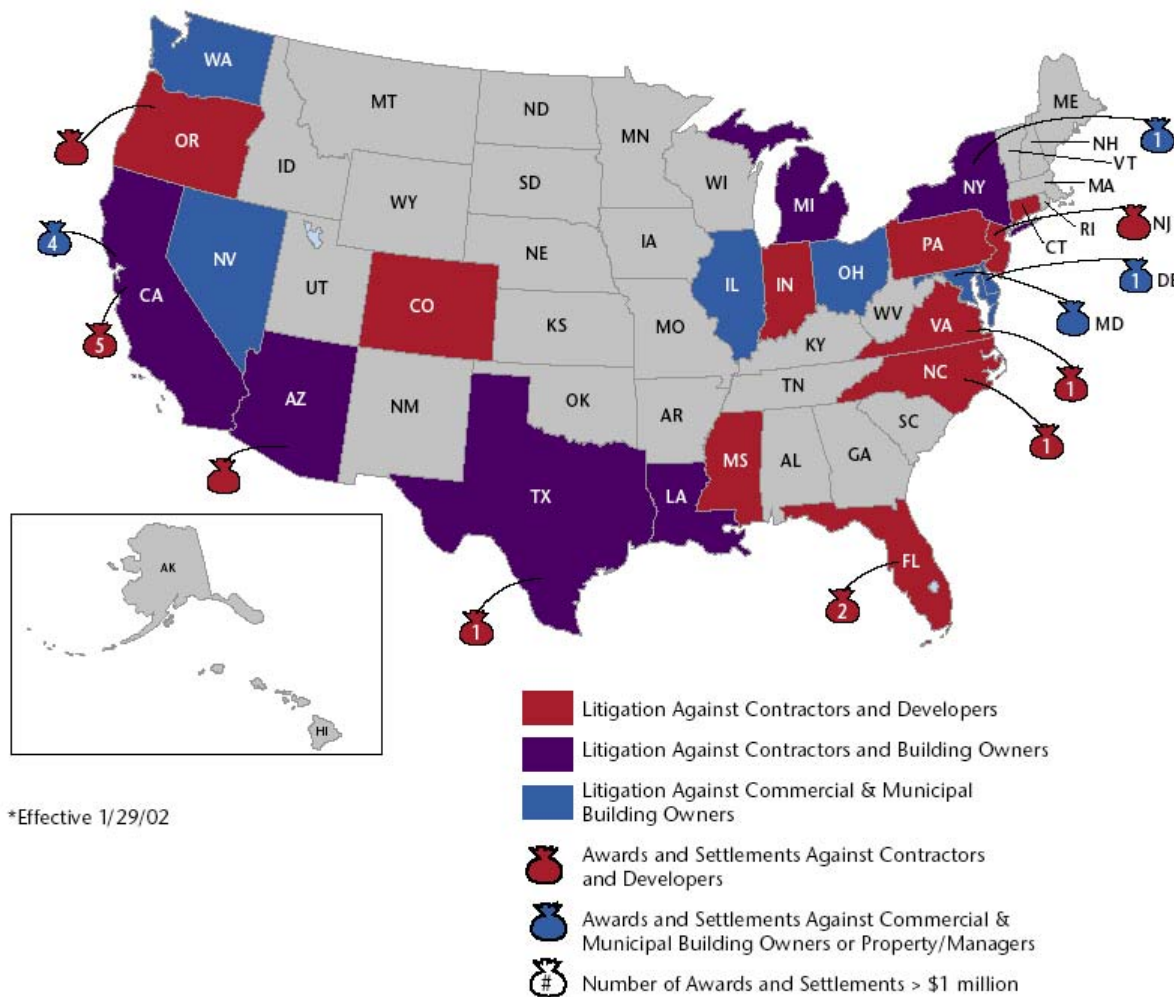


## % Outside Air vs. Design Dew Point vs. HVAC SHR

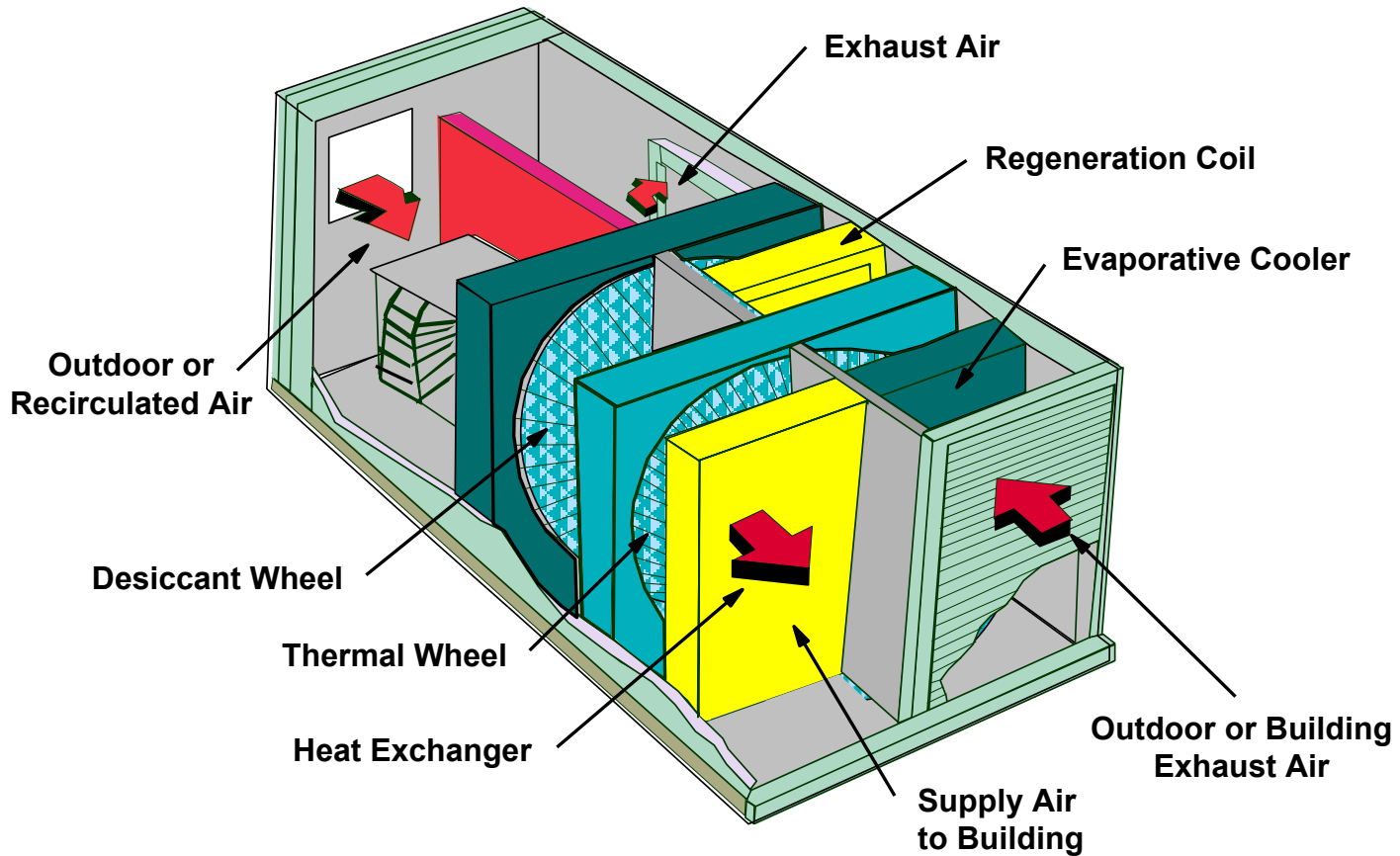




# Mold Litigation Against Contractors and Commercial & Municipal Building Owners



\*Effective 1/29/02

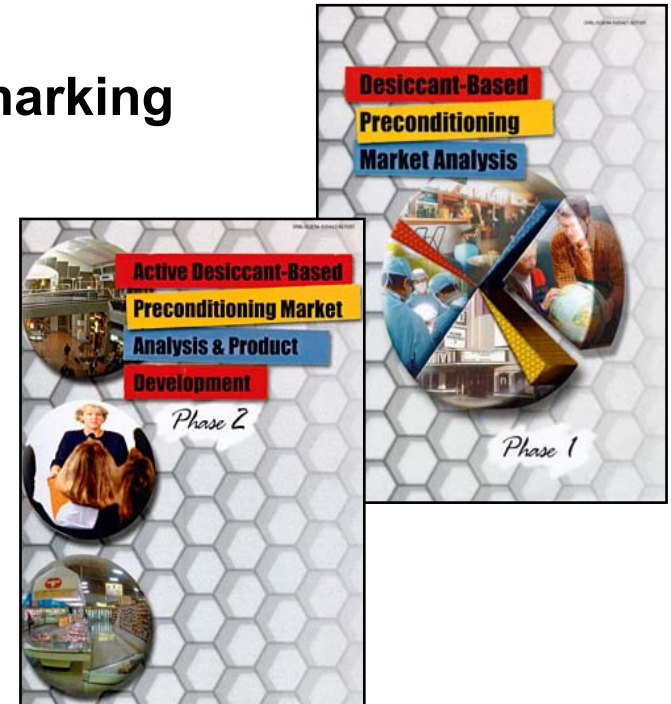




# ORNL Advanced Desiccant “Systems” Program

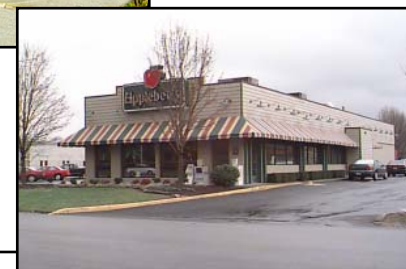


- **Goal:** Facilitate market introduction of cost-effective, energy efficient desiccant-based dehumidification technologies into mainstream HVAC comfort conditioning systems
- **Strategic Approach - Industry/User Groups Program Plan**
  - ⇒ Market Assessments/System Benchmarking
  - ⇒ New Product/System Development
  - ⇒ Enabling Technologies Development
    - IAQ Benefits
    - Sensors/Controls Technology
    - Product Rating and Certification
  - ⇒ Integration with CHP Systems



# System Benchmarking of Commercial Equipment Performance

- Restaurants - Theaters - Schools - Nursing Homes - Hospitals
- Laboratory - controlled environment testing



## Parametric Analysis of Variables That Affect the Performance of a Desiccant Dehumidification System

Edward A. Vineyard, P.E. James R. Sand, Ph.D. David J. Dur

### ABSTRACT

Desiccant dehumidification systems, which are used to reduce the moisture (latent load) of the conditioned air in buildings, are typically specified on the basis of grain depression (pounds of water removed per hour) for a given volumetric flow rate of air at a specified dry-bulb or wet-bulb temperature. While grain depression gives some indication of the performance of the system, it does not adequately describe the efficiency of the moisture removal process. Several operating parameters, such as desiccant wheel speed, regeneration temperature, volumetric air flow rate, wheel thickness, sector angle, and desiccant loading, affect the ability of the desiccant dehumidification system to remove moisture. There are as many design parameters that influence the operation of a desiccant system that it is difficult to quantify the impact from the interaction on system performance. The purpose of this study is to investigate the impact of varying some of these operating parameters on the performance of a desiccant dehumidification system and to report the results using more quantitative measures, such as latent capacity and latent coefficient of performance (COP), that better describe the efficiency of the moisture removal process. The results will be used to improve the understanding of the operation of desiccant systems and to compare their performance by changing certain operating parameters or improving components.

Two desiccant loadings were tested: one at normal production level and the other with 25% more desiccant applied to the wheel. For both desiccant loadings, the latent capacity and COP increased as desiccant wheel speed increased. As expected, latent capacity improved significantly as air flow rate increased. It is noted, however, that the efficiency (latent COP) was quite sensitive to air flow rate and showed a maximum at a particular flow rate. The other operating parameters resulted in increases in latent capacity for both desiccant loadings or no change in latent COP. Therefore, means of achieving higher regeneration temperature should be investigated.

### INTRODUCTION

In an effort to accelerate the widespread use of desiccant dehumidification systems in commercial buildings, an industry-government cooperative research and development program (CRADA) was established in 1994. The objectives of the CRADA were to: (1) significantly improve indoor air quality by decreasing the use of halogenated refrigerant compression equipment; (2) reduce air conditioning energy consumption; and (3) introduce new markets for U.S. industry through expanded desiccant dehumidification systems. In addition, CRADA will be used to support investigations under development for desiccant systems.

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) has recommended that indoor levels of relative humidity be maintained between 30% and 60% and the wet-bulb temperature be maintained below 60°F. In addition, ASHRAE has introduced design standards for 25% humidity in the United States as an incentive to size and select building loads.

Edward A. Vineyard and James R. Sand are research engineers in Oak Ridge National Laboratory, Oak Ridge, Tenn. The research division at the University of Tennessee, Knoxville.



Regal - Cobb Theater Desiccant Installation

## Active Desiccant HVAC Comes To Foodservice



By Brian Ward

It's not that any old day, but in the world of things, foodservice HVAC is a hot topic. In fact, it's one of the most important topics in the industry today. And it's not just about the equipment itself, but about the way it's used. The active desiccant HVAC system is a new technology that's been developed to meet the needs of the foodservice industry. It's a system that's designed to provide a clean, dry, and comfortable environment for the kitchen and the dining area. The system is made up of several components, including a desiccant wheel, a fan, and a control system. The desiccant wheel is the heart of the system. It's a wheel that's made of a material that can absorb moisture. As air passes through the wheel, the moisture is absorbed, and the air is dried. The fan then blows the dried air into the kitchen or the dining area. The control system is what makes the system work. It's a computerized system that monitors the humidity and the temperature of the air. When the humidity is too high, the system automatically turns on the fan and the desiccant wheel. When the humidity is low, the system turns off the fan and the desiccant wheel. This system is a great way to keep the kitchen and the dining area dry and comfortable. It's a system that's been developed by a company called Active Desiccant. They're a company that's been in the business for a long time. They've developed a lot of different systems, and they've been successful in a lot of different markets. They're a company that's been in the business for a long time. They've developed a lot of different systems, and they've been successful in a lot of different markets.

## CHARACTERIZATION OF HEAT RECOVERY WHEELS IN THERMALLY REGENERATED DESICCANT SYSTEMS UTILIZING EVAPORATIVE COOLING

Izadeh-Azar, Ph.D., P.E. (Mississippi State University) and James R. Sand, Ph.D., and Vineyard, P.E. (Oak Ridge National Laboratory)

A paper submitted for the 34<sup>th</sup> National Heat Transfer Conference Pittsburgh, PA, August 20-22, 2000.

The dynamics of thermal regeneration via a rotating wheel coupled with evaporative cooling and desiccant, dehumidification system are explored in relation to system efficiency and implementation of these features reduces the sensible cooling load of the supply air, but also the dehumidification (latent) capacity of the system due to moisture transfer to the dry air. The conflicting nature of these attributes necessitates examination of the system parameters with respect to the rotational speed of the thermal recovery wheel and the evaporative cooling.

Performance parameters considered in this study are dehumidification (latent) capacity, COP for the latent capacity, and an overall COP based on the net capacity. By using the net effect of the latent capacity and the sensible load, the net capacity and the COP offer an appropriate means for a comprehensive examination of the system performance.

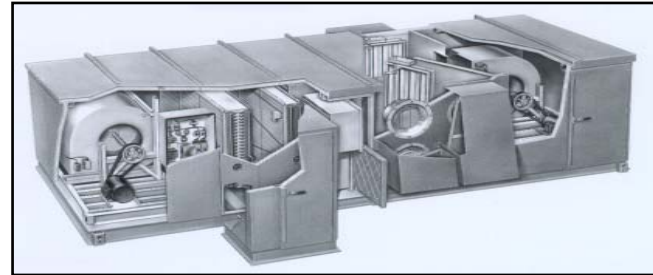
The results of this study indicate that, for the inlet air conditions considered, the thermal recovery wheel in conjunction with evaporative cooling of regeneration air leads to enhancement of the



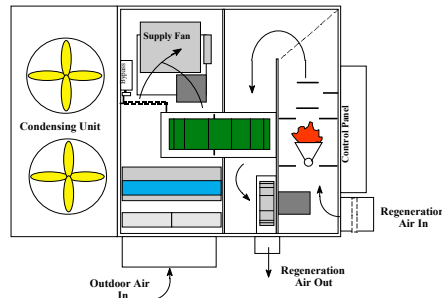
# New Product Development -



- **SEMCO/Trane - Active Desiccant/Total Energy Recovery Collaboration -- Berry College and Georgia Tech Baker Bldg.**



- **Active Desiccant Module/Unitary Rooftop Combination -- Callaway Resort and Golf Club and Chain Restaurant**



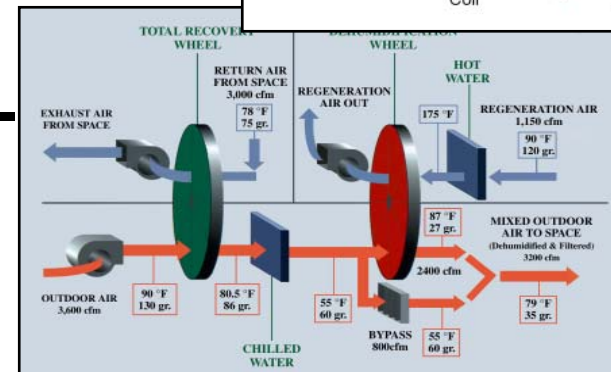
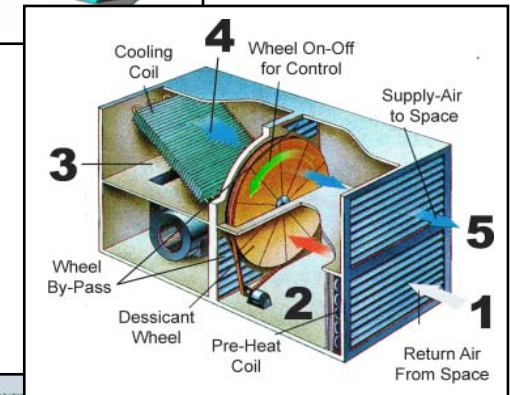
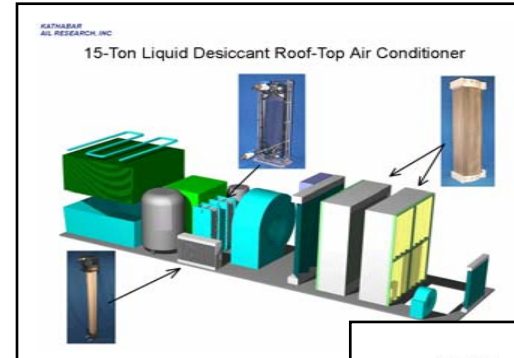


# New Products - “Novel/Combined Systems” -



## - Current RFP Winners -

- Kathabar - AIL Research  
*Rooftop Liquid-Desiccant Air Conditioner (Sensible + Latent)*
- Trane/UCF/FSEC/AirXchange -  
*Trane Active Cromer Cycle*
- SEMCO/C&M Engineering/UIC -  
*Active Desiccant/Total Energy Recovery Hybrid*

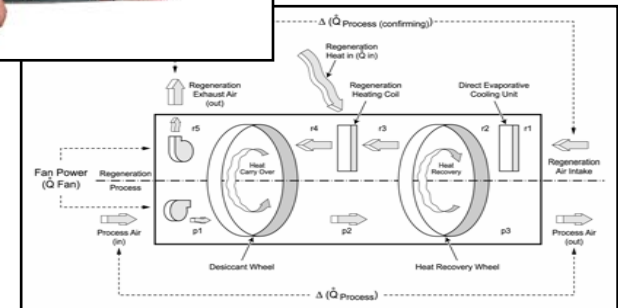
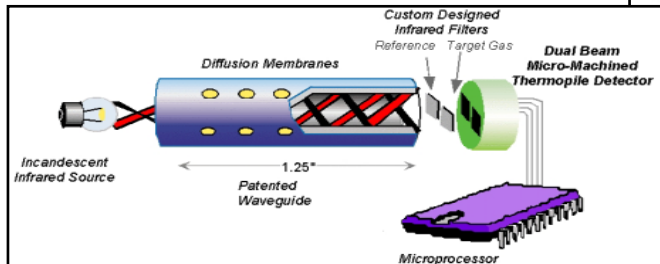
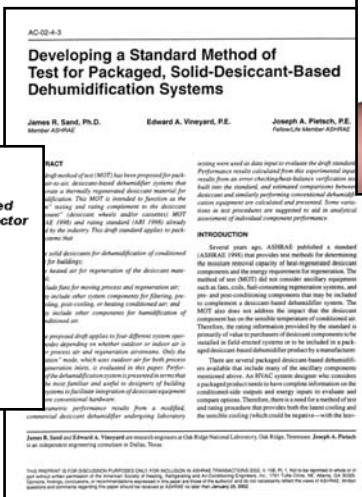
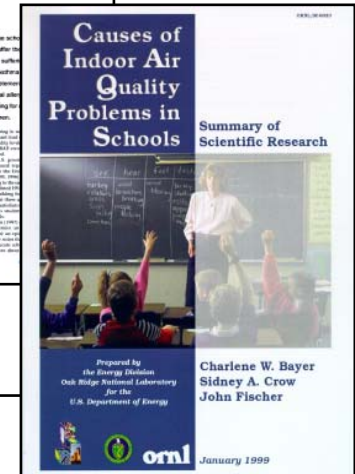




# Enabling Technologies Development



- Establish IAQ Benefits  
Schools IAQ Studies
- NDIR Sensors --  
H<sub>2</sub>O/CO<sub>2</sub> DCV and  
Comfortstats
- Rating and  
Certification Standard





# **Key Technical & Programmatic Challenges - Desiccant Technology**



- **Equipment First Cost -- Operating Cost**
- **Entrenched/Established Vapor-Compression alternative technology and infrastructure**
- **Small number of commercial desiccant equipment manufacturers**



# Coordination with Stakeholder Groups, Other EERE Programs



- **Industries** -- AirXchange – Munters – SEMCO – Trane – Air Technology Systems (ATS) – Dryomatic – Bry-Air – Kathabar
- **Universities** -- University of Illinois-Chicago (UIC) – Mississippi State University (GCDT) – Georgia Tech Research Institute (GTRI) – University of Central Florida - Kansas State U.
- **Independent Research Groups** -- Energystics – Sustainable Design Group – AIL Research – CDH Energy Corp. – FSEC
- **Utilities** -- Mississippi Valley Gas – Tampa Electric Company (TECO) – Philadelphia Energy Company (PECO) – Clearwater Gas – Peoples-Gas Miami – United Cities Gas – etc.
- **Research Organizations** -- ASHRAE – ARI – IGT – AGCC – GTI (GRI)
- **FEMP - NREL**